AD NO. ___________________________
DTC PROJECT NO. 8-CO-160-UXO-021
REPORT NO. ATC-9693

STANDARDIZED

UXO TECHNOLOGY DEMONSTRATION SITE

OPEN FIELD SCORING RECORD NO. 887

SITE LOCATION:
U.S. ARMY ABERDEEN PROVING GROUND

DEMONSTRATOR:
GAP GEOPHYSICS
QLD 4061
212 HILDER ROAD
AUSTRALIA
TECHNOLOGY TYPE/PLATFORM:
SAM DUAL MODE/PUSHCART

PREPARED BY:
U.S. ARMY ABERDEEN TEST CENTER
ABERDEEN PROVING GROUND, MD 21005-5059

JUNE 2008

Prepared for:
U.S. ARMY ENVIRONMENTAL COMMAND
ABERDEEN PROVING GROUND, MD 21010-5401

U.S. ARMY DEVELOPMENTAL TEST COMMAND
ABERDEEN PROVING GROUND, MD 21005-5055

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MEMORANDUM FOR RECORD

SUBJECT: Operations Security (OPSEC) Review of Paper/Presentation

1. The attached scoring record entitled "Open Field Scoring Record No. 887" dated June 2008 is provided for review for public disclosure in accordance with AR 530-1 as supplemented. The scoring record is proposed for public release via the internet.

2. I, the undersigned, am aware of the intelligence interest in open source publications and in the subject matter of the information I have reviewed for intelligence purposes. I certify that I have sufficient technical expertise in the subject matter of this scoring record and that, to the best of my knowledge, the net benefit of this public release outweighs the potential damage to the essential secrecy of all related ATC, DTC, ATEC, Army or other DOD programs of which I am aware.

Dennis Teefy	Dennis A Teefy	June 2008
NAME (Printed)	SIGNATURE	DATE

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as

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None

14. ABSTRACT

This scoring record documents the efforts of GAP Geophysics to detect and discriminate inert unexploded ordnance (UXO) utilizing the APG Standardized UXO Technology Demonstration Site Blind Grid. This Scoring Record was coordinated by Dennis Teefy and the Standardized UXO Technology Demonstration Site Scoring Committee. Organizations on the committee include the U.S. Army Corps of Engineers, the Environmental Security Technology Certification Program, the Strategic Environmental Research and Development Program, the Institute for Defense Analysis, the U.S. Army Environmental Command, and the U.S. Army Aberdeen Test Center.

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SECTION 1. GENERAL INFORMATION

1.1 BACKGROUND

Technologies under development for the detection and discrimination of munitions and explosives of concern (MEC) – i.e. unexploded ordnance (UXO) and discarded military munitions (DMM) require testing so that their performance can be characterized. To that end, Standardized Test Sites have been developed at U.S. Army Aberdeen Proving Ground (APG), Maryland, and U.S. Army Yuma Proving Ground (YPG), Arizona. These test sites provide a diversity of geology, climate, terrain, and weather as well as diversity in ordnance and clutter. Testing at these sites is independently administered and analyzed by the government for the purposes of characterizing technologies, tracking performance with system development, comparing performance of different systems, and comparing performance in different environments.

The Standardized UXO Technology Demonstration Site Program is a multiagency program spearheaded by the U.S. Army Environmental Command (USAEC). The U.S. Army Aberdeen Test Center (ATC) and the U.S. Army Corps of Engineers Engineer Research and Development Center (ERDC) provide programmatic support. The program is being funded and supported by the Environmental Security Technology Certification Program (ESTCP), the Strategic Environmental Research and Development Program (SERDP) and the Army Environmental Quality Technology Program (EQT).

1.2 SCORING OBJECTIVES

The objective in the Standardized UXO Technology Demonstration Site Program is to evaluate the detection and discrimination capabilities of a given technology under various field and soil conditions. Inert munitions and clutter items are positioned in various orientations and depths in the ground.

The evaluation objectives are as follows:

a. To determine detection and discrimination effectiveness under realistic scenarios that vary targets, geology, clutter, topography, and vegetation.

b. To determine cost, time, and manpower requirements to operate the technology.

c. To determine demonstrator's ability to analyze survey data in a timely manner and provide prioritized "Target Lists" with associated confidence levels.

d. To provide independent site management to enable the collection of high quality, ground-truth, geo-referenced data for post-demonstration analysis.

1.2.1 Scoring Methodology

a. The scoring of the demonstrator's performance is conducted in two stages. These two stages are termed the RESPONSE STAGE and DISCRIMINATION STAGE. For both stages, the probability of detection (P_d) and the false alarms are reported as receiver-operating characteristic (ROC) curves. False alarms are divided into those anomalies that correspond to emplaced clutter items, measuring the probability of false positive (P_{fp}), and those that do not correspond to any known item, termed background alarms.

b. The RESPONSE STAGE scoring evaluates the ability of the system to detect emplaced targets without regard to ability to discriminate ordnance from other anomalies. For the blind grid RESPONSE STAGE, the demonstrator provides the scoring committee with a target response from each and every grid square along with a noise level below which target responses are deemed insufficient to warrant further investigation. This list is generated with minimal processing and, since a value is provided for every grid square, will include signals both above and below the system noise level.

c. The DISCRIMINATION STAGE evaluates the demonstrator's ability to correctly identify ordnance as such and to reject clutter. For the blind grid DISCRIMINATION STAGE, the demonstrator provides the scoring committee with the output of the algorithms applied in the discrimination-stage processing for each grid square. The values in this list are prioritized based on the demonstrator's determination that a grid square is likely to contain ordnance. Thus, higher output values are indicative of higher confidence that an ordnance item is present at the specified location. For digital signal processing, priority ranking is based on algorithm output. For other discrimination approaches, priority ranking is based on human (subjective) judgment. The demonstrator also specifies the threshold in the prioritized ranking that provides optimum performance, (i.e. that is expected to retain all detected ordnance and rejects the maximum amount of clutter).

d. The demonstrator is also scored on EFFICIENCY and REJECTION RATIO, which measures the effectiveness of the discrimination stage processing. The goal of discrimination is to retain the greatest number of ordnance detections from the anomaly list, while rejecting the maximum number of anomalies arising from non-ordnance items. EFFICIENCY measures the fraction of detected ordnance retained after discrimination, while the REJECTION RATIO measures the fraction of false alarms rejected. Both measures are defined relative to performance at the demonstrator-supplied level below which all responses are considered noise, i.e., the maximum ordnance detectable by the sensor and its accompanying false positive rate or background alarm rate.

e. Based on configuration of the ground truth at the standardized sites and the defined scoring methodology, there exists the possibility of having anomalies within overlapping halos and/or multiple anomalies within halos. In these cases, the following scoring logic is implemented:

(1) In situations where multiple anomalies exist within a single R_{halo}, the anomaly with the strongest response or highest ranking will be assigned to that particular ground truth item.

(2) For overlapping R_{halo} situations, ordnance has precedence over clutter. The anomaly with the strongest response or highest ranking that is closest to the center of a particular ground truth item gets assigned to that item. Remaining anomalies are retained until all matching is complete.

(3) Anomalies located within any R_{halo} that do not get associated with a particular ground truth item are thrown out and are not considered in the analysis.

f. All scoring factors are generated utilizing the Standardized UXO Probability and Plot Program, version 3.1.1.

1.2.2 <u>Scoring Factors</u>

Factors to be measured and evaluated as part of this demonstration include:

a. Response Stage ROC curves:

(1) Probability of Detection (P_d^{res}).

(2) Probability of False Positive (P_{fp}^{res}).

(3) Background Alarm Rate (BAR^{res}) or Probability of Background Alarm (P_{BA}^{res}).

b. Discrimination Stage ROC curves:

(1) Probability of Detection (P_d^{disc}).

(2) Probability of False Positive (P_{fp}^{disc}).

(3) Background Alarm Rate (BAR^{disc}) or Probability of Background Alarm (P_{BA}^{disc}).

c. Metrics:

(1) Efficiency (E).

(2) False Positive Rejection Rate (R_{fp}).

(3) Background Alarm Rejection Rate (R_{BA}).

d. Other:

(1) Probability of Detection by Size and Depth.

(2) Classification by type (i.e., 20-, 40-, 105-mm, etc.).

(3) Location accuracy.

(4) Equipment setup, calibration time and corresponding man-hour requirements.

(5) Survey time and corresponding man-hour requirements.

(6) Reacquisition/resurvey time and man-hour requirements (if any).

(7) Downtime due to system malfunctions and maintenance requirements.

1.3 STANDARD AND NONSTANDARD INERT ORDNANCE TARGETS

The standard and nonstandard ordnance items emplaced in the test areas are listed in Table 1. Standardized targets are members of a set of specific ordnance items that have identical properties to all other items in the set (caliber, configuration, size, weight, aspect ratio, material, filler, magnetic remanence, and nomenclature). Nonstandard targets are inert ordnance items having properties that differ from those in the set of standardized targets.

TABLE 1. INERT ORDNANCE TARGETS

Standard Type	Nonstandard (NS)
20-mm Projectile M55	20-mm Projectile M55
	20-mm Projectile M97
40-mm Grenades M385	40-mm Grenades M385
40-mm Projectile MKII Bodies	40-mm Projectile M813
BDU-28 Submunition	
BLU-26 Submunition	
M42 Submunition	
57-mm Projectile APC M86	
60-mm Mortar M49A3	60-mm Mortar (JPG)
	60-mm Mortar M49
2.75-inch Rocket M230	2.75-inch Rocket M230
	2.75-inch Rocket XM229
MK 118 ROCKEYE	
81-mm Mortar M374	81-mm Mortar (JPG)
	81-mm Mortar M374
105-mm Heat Rounds M456	
105-mm Projectile M60	105-mm Projectile M60
155-mm Projectile M483A1	155-mm Projectile M483A
	500-lb Bomb

JPG = Jefferson Proving Ground.
HEAT = high-explosive antitank.

SECTION 2. DEMONSTRATION

2.1 DEMONSTRATOR INFORMATION

2.1.1 Demonstrator Point of Contact (POC) and Address

POC: Mr. Stephen Griffin
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Address: GAP Geophysics Australia PTY Limited
ABN 67 116 407 580
212 Hilder Road
The GAP QLD 4061
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2.1.2 System Description (provided by demonstrator)

Sub Audio Magnetics (SAM) is a method by which a total field magnetometer sampling at a very high rate may be used to simultaneously acquire both Total Magnetic Intensity (TMI) and Total Field Electromagnetic Induction (TFEMI) data. The SAM system consists of the following components:

a. Magnetometer. The SAM capable TM-6 magnetometer to be used has been developed and built by G-tek. Its salient features include:

(1) Accepts Larmor signal input from a hand-held array of four optically pumped magnetic sensors.

(2) Simultaneously acquires magnetic field measurements from each sensor at selectable rates up to 4,800 per second.

(3) Measurements are acquired at precisely equal time intervals that are synchronized to Global Positioning System (GPS) time.

(4) The RMS noise floor for each measurement sample rate typically lies between 1 nT at 10,000 per second to 1 pT at 100 per second when plotted on a logarithmic abscissa (in this program we propose sampling at 4,800 per second at which the noise is approximately 0.2 nT, reducible in late-time by the averaging of consecutive samples.

(5) Accepts position and time information including 1 pps strobe from DGPS.

(6) Magnetometer, DGPS and batteries to power a quad-sensor array for typically 2.5 hours are carried in a back-pack of total weight approximately 8kg.

(7) Graphic user interface implemented on a Pocket PC.

b. Electromagnetic Transmitter. An 8-turn wire loop is laid out along a meandering path surrounding the grid area to be surveyed (typically 33m x 33m). A Zonge GGT-10 current transmitter energizes this loop with a bi-polar, 12 - 20 amp square wave current of typically 50 percent duty cycle and 15Hz frequency. The transmitter and receiving magnetometer are precisely synchronized using GPS time.

c. Data Positioning Systems. The TM-6 magnetometer system has been designed to interface with a variety of positioning devices as different application localities have different characteristics and requirements. There is a requirement when using the magnetometer for SAM applications that access is available to GPS time at least once about every 30 minutes in order to maintain precise clock synchronization. However, this time signal may be obtainable in conditions such as wooded areas where DGPS positional accuracy is not satisfactory. In such situations a cotton thread based odometer system developed by G-tek and used for over 25 years provides a good alternative. However, emerging new technologies such as the robotic total station (RTS) have been allowed for in the design of the magnetometer. At the Aberdeen Proving Ground site it is proposed that both the odometer and RTS will be used in the forested area for the purpose of evaluating their relative performance.

Figure 1. GAP's system, SAM dual mode.

2.1.3 <u>Data Processing Description (provided by demonstrator)</u>

The raw TM-6 data is processed using a proprietary software package referred to as 'MagPi' which performs all preprocessing procedures including separation of the magnetic (TMI) and electromagnetic data (TFEMI) sets, waveform stacking, removal of unwanted

frequency components such as 60 Hz noise, electromagnetic (EM) decay curve integration, decimation, merging of DGPS time/position and low-pass filtering. The MagPi output is usually in the form of Excel style csv files (time decays) or Geosoft XYZ files. The Geosoft Mapping Package is used for data management, gridding, map creation and display and other specialized filtering. Two proprietary products referred to as ‘MagSys’ (G-tek) and ‘UXOlab’ (University of British Columbia’) are used for additional interpretation of the gridded data, in order to provide automatic anomaly picking, calculation of certain anomaly parameters, forward modeling and inversion. The SAM electromagnetic interference (EMI) method provides two complementary data sets (TMI and TFEMI) that are perfectly geo-referenced because the same sensor is used to acquire both data types simultaneously. For these technology demonstrations the individual data sets will be processed separately to the point of producing the XYZ files, but the results will be presented as a single joint interpretation, using selected information from each data set combined in a logical and optimal manner. In the specific case of small ordnance items such as grenades and submunitions, the TFEMI response is likely to be below the noise floor with the TFEMI, in which case the interpretation will be based on the TMI alone.

2.1.4 Data Submission Format

Data were submitted for scoring in accordance with data submission protocols outlined in the Standardized UXO Technology Demonstration Site Handbook. These submitted data are not included in this report in order to protect ground truth information.

2.1.5 Demonstrator Quality Assurance (QA) and Quality Control (QC) (provided by demonstrator)

a. Overview of Quality Control (QC). Prior to the commencement of survey each day, a system integrity test procedure will be conducted exceeding the requirements of DID 005 05.02. This procedure will include:

(1) A test for sensor warm-up and signal health.

(2) The testing of personnel for demagnetization and metal-free clothing.

(3) A cable vibration test in conjunction with in-built system integrity checks.

(4) A sensor array position check.

(5) Acquiring a DGPS latency, sensor offset, and data integrity record using a six-line test performed over the energized wire loop.

(6) A heading and azimuthal test.

(7) A repeat line test.

(8) Occupying a known position and recording its measured position.

b. Overview of Quality Assurance (QA). The most important aspect of quality assurance for this demonstration is that all measurements are accurately recorded and well documented. Detailed signed and dated field notes will accompany all digital data files. The QA officer (JMS) will independently evaluate the calibration data files and the demonstration survey data files. Data not compliant with the survey specifications will be reacquired.

2.1.6 Additional Records

The following record(s) by this vendor can be accessed via the Internet as Microsoft Word documents at www.uxotestsites.org. The blind grid counterpart to this report is Scoring Record No. 886.

2.2 APG SITE INFORMATION

2.2.1 Location

The APG Standardized Test Site is located within a secured range area of the Aberdeen Area. The Aberdeen Area of APG is located approximately 30 miles northeast of Baltimore at the northern end of the Chesapeake Bay. The Standardized Test Site encompasses 17 acres of upland and lowland flats, woods and wetlands.

2.2.2 Soil Type

According to the soils survey conducted for the entire area of APG in 1998, the test site consists primarily of Elkton Series type soil (ref 2). The Elkton Series consist of very deep, slowly permeable, poorly drained soils. These soils formed in silty aeolin sediments and the underlying loamy alluvial and marine sediments. They are on upland and lowland flats and in depressions of the Mid-Atlantic Coastal Plain. Slopes range from 0 to 2 percent.

ERDC conducted a site-specific analysis in May of 2002 (ref 3). The results basically matched the soil survey mentioned above. Seventy percent of the samples taken were classified as silty loam. The majority (77 percent) of the soil samples had a measured water content between 15- and 30-percent with the water content decreasing slightly with depth.

For more details concerning the soil properties at the APG test site, go to www.uxotestsites.org on the Web to view the entire soils description report.

2.2.3 Test Areas

A description of the test site areas at APG is included in Table 2.

TABLE 2. TEST SITE AREAS

Area	Description
Calibration grid	Contains 14 standard ordnance items buried in six positions at various angles and depths to allow demonstrator to calibrate their equipment.
Blind test grid	Contains 400 grid cells in a 0.2-hectare (0.5 acre) site. The center of each grid cell contains ordnance, clutter, or nothing.
Open field	A 4-hectare (10-acre) site containing open areas, dips, ruts and obstructions that challenge platform systems or hand held detectors. The challenges include a gravel road, wet areas and trees. The vegetation height varies from 15 to 25 cm.

SECTION 3. FIELD DATA

3.1 DATE OF FIELD ACTIVITIES (8, 9, 11 through 16, 18 through 20, and 25 through 27 June 2007)

3.2 AREAS TESTED/NUMBER OF HOURS

Areas tested and total number of hours operated at each site are summarized in Table 3.

TABLE 3. AREAS TESTED AND NUMBER OF HOURS

Area	Number of Hours
Calibration lanes	12.42
Open field	91.25

3.3 TEST CONDITIONS

3.3.1 Weather Conditions

An APG weather station located approximately 1 mile west of the test site was used to record average temperature and precipitation on a half-hour basis for each day of operation. The temperatures listed in Table 4 represent the average temperature during field operations from 0700 to 1700 hours while precipitation data represents a daily total amount of rainfall. Hourly weather logs used to generate this summary are provided in Appendix B.

TABLE 4. TEMPERATURE/PRECIPITATION DATA SUMMARY

Date, 2007	Average Temperature, ^{o}F	Total Daily Precipitation, in.
8 June	85.1	0.00
9 June	81.3	0.04
11 June	76.9	0.00
12 June	79.2	0.08
13 June	74.3	0.00
14 June	62.9	0.00
15 June	68.4	0.00
16 June	74.6	0.00
18 June	85.9	0.00
19 June	84.6	0.00
20 June	76.6	0.11
25 June	77.3	0.49
26 June	85.5	0.00
27 June	86.3	0.00

3.3.2 <u>Field Conditions</u>

GAP surveyed the open field on 12 through 16, 18 through 20, and 25 through 27 June 2007. The weather was warm and the field was dry most days during this period.

3.3.3 <u>Soil Moisture</u>

Three soil probes were placed at various locations within the site to capture soil moisture data: blind grid, calibration, mogul, and wooded areas. Measurements were collected in percent moisture and were taken twice daily (morning and afternoon) from five different soil depths (1 to 6 in., 6 to 12 in., 12 to 24 in., 24 to 36 in., and 36 to 48 in.) from each probe. Soil moisture logs are included in Appendix C.

3.4 FIELD ACTIVITIES

3.4.1 <u>Setup/Mobilization</u>

These activities included initial mobilization and daily equipment preparation and break down. A three-person crew took 7 hours and 25 minutes to perform the initial setup and mobilization. There was 29 hours and 25 minutes of daily equipment preparation and end of the day equipment break down lasted 3 hours and 5 minutes.

3.4.2 <u>Calibration</u>

GAP spent a total of 12 hours and 25 minutes in the calibration lanes, of which 5 hours and 40 minutes was spent collecting data. Additionally GAP spent 1 hour and 40 minutes calibrating while surveying the open field.

3.4.3 <u>Downtime Occasions</u>

Occasions of downtime are grouped into five categories: equipment/data checks or equipment maintenance, equipment failure and repair, weather, demonstration site issues, or breaks/lunch. All downtime is included for the purposes of calculating labor costs (section 5) except for downtime due to demonstration site issues. Demonstration site issues, while noted in the daily log, are considered non-chargeable downtime for the purposes of calculating labor costs and are not discussed. Breaks and lunches are discussed in this section and billed to the total site survey area.

3.4.3.1 <u>Equipment/data checks, maintenance</u>. Equipment data checks and maintenance activities accounted for no site usage time. These activities included changing out batteries and performing routine data checks to ensure the data was being properly recorded/collected. GAP spent an additional 10 hours and 20 minutes for breaks and lunches.

3.4.3.2 <u>Equipment failure or repair</u>. A total of 1 hour and 10 minutes was needed to resolve equipment failures that occurred while surveying the open field. An axle snapped on the cart requiring 15 minutes to repair. Also, a broken cable connection required 55 minutes to fix.

3.4.3.3 Weather. Two weather delays occurred during the survey. On 12 and 13 June lightning warnings required GAP to go indoors for a short period of time. A total of 1 hour and 15 minutes was needed before appropriate weather ensued.

3.4.4 Data Collection

GAP spent a total of 91 hours and 15 minutes in the open field area, 46 hours of which was spent collecting data.

3.4.5 Demobilization

The GAP survey crew went on to conduct a full demonstration of the site. Therefore, demobilization did not occur until 27 June 2007. On that day, it took the crew 1 hour and 40 minutes to break down and pack up their equipment.

3.5 PROCESSING TIME

GAP submitted the raw data from the demonstration activities on the last day of the demonstration, as required. The scoring submittal data was provided 22 January 2008.

3.6 DEMONSTRATOR'S FIELD PERSONNEL

Steve Griffith - Manager and research development
Chris Parker - Staff geophysicist
Peter Richards - Field technician
Cameron Cattach - Field technician

3.7 DEMONSTRATOR'S FIELD SURVEYING METHOD

GAP surveyed the open field in a linear fashion and used 1 meter line spacing.

3.8 SUMMARY OF DAILY LOGS

Daily logs capture all field activities during this demonstration and are located in Appendix D. Activities pertinent to this specific demonstration are indicated in highlighted text.

SECTION 4. TECHNICAL PERFORMANCE RESULTS

4.1 ROC CURVES USING ALL ORDNANCE CATEGORIES

Figure 2, 4, and 6 shows the probability of detection for the response stage (P_d^{res}) and the discrimination stage (P_d^{disc}) versus their respective probability of false positive for the EM sensor(s), MAG sensor(s) and combined EM/MAG picks respectively. Figure 3, 5, and 7 shows both probabilities plotted against their respective background alarm rate. Both figures use horizontal lines to illustrate the performance of the demonstrator at two demonstrator-specified points: at the system noise level for the response stage, representing the point below which targets are not considered detectable, and at the demonstrator's recommended threshold level for the discrimination stage, defining the subset of targets the demonstrator would recommend digging based on discrimination. Note that all points have been rounded to protect the ground truth.

The overall ground truth is composed of ferrous and non-ferrous anomalies. Because of the limitations of the magnetometer, the non-ferrous items cannot be detected. Therefore, the ROC curves presented in Figures 4 and 5 of this section are based on the subset of the ground truth that is solely made up of ferrous anomalies.

N/A

Figure 2. EM Sensor open field probability of detection for response and discrimination stages versus their respective probability of false positive over all ordnance categories combined.

N/A

Figure 3. EM Sensor open field probability of detection for response and discrimination stages versus their respective background alarm rate over all ordnance categories combined.

N/A

Figure 4. MAG Sensor open field probability of detection for response and discrimination stages versus their respective probability of false positive over all ordnance categories combined.

N/A

Figure 5. MAG Sensor open field probability of detection for response and discrimination stages versus their respective background alarm rate over all ordnance categories combined.

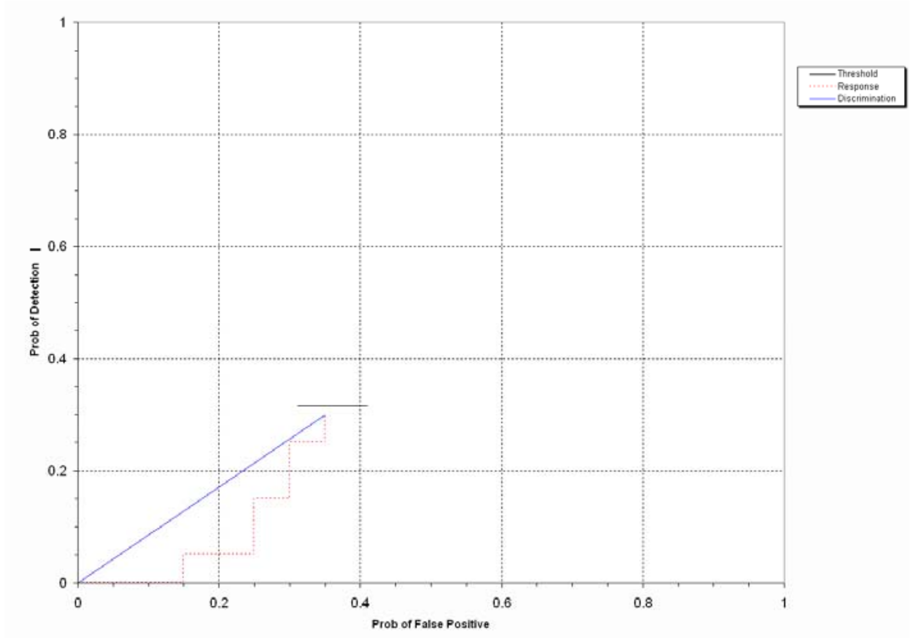

Figure 6. Combined Sensor open field probability of detection for response and discrimination stages versus their respective probability of false positive over all ordnance categories combined.

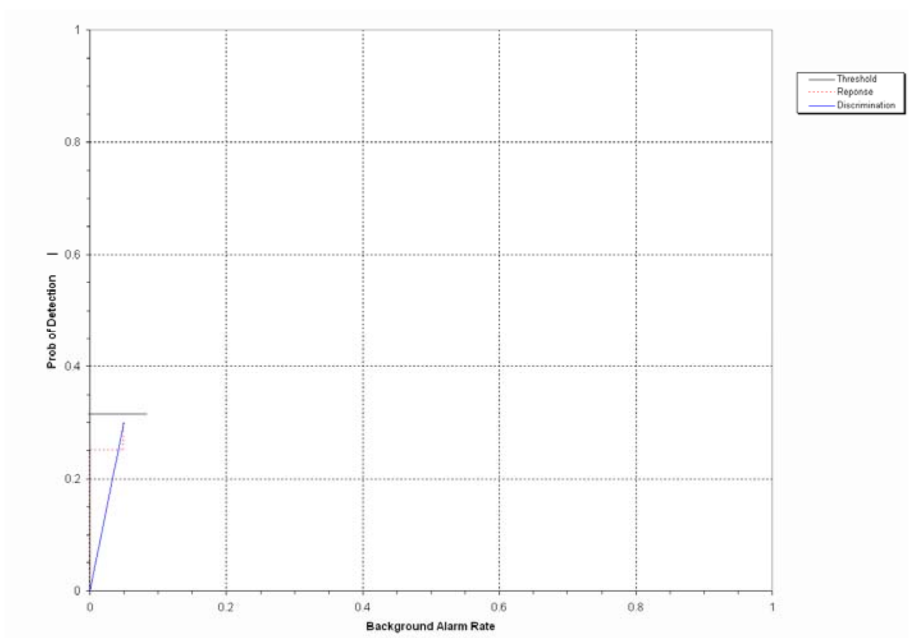

Figure 7. Combined Sensor open field probability of detection for response and discrimination stages versus their respective background alarm rate over all ordnance categories combined.

4.2 ROC CURVES USING ORDNANCE LARGER THAN 20 MM

Figure 8, 10, and 12 shows the probability of detection for the response stage (P_d^{res}) and the discrimination stage (P_d^{disc}) versus their respective probability of false positive when only targets larger than 20 mm are scored for the EM sensor(s), MAG sensor(s) and Combined EM/MAG picks respectively. Figure 9, 11, and 13 shows both probabilities plotted against their respective background alarm rate. Both figures use horizontal lines to illustrate the performance of the demonstrator at two demonstrator-specified points: at the system noise level for the response stage, representing the point below which targets are not considered detectable, and at the demonstrator's recommended threshold level for the discrimination stage, defining the subset of targets the demonstrator would recommend digging based on discrimination. Note that all points have been rounded to protect the ground truth.

The overall ground truth is composed of ferrous and non-ferrous anomalies. Because of the limitations of the magnetometer, the non-ferrous items cannot be detected. Therefore, the ROC curves presented in Figures 10 and 11 of this section are based on the subset of the ground truth that is solely made up of ferrous anomalies.

N/A

Figure 8. EM Sensor open field probability of detection for response and discrimination stages versus their respective probability of false positive for all ordnance larger than 20 mm.

N/A

Figure 9. EM Sensor open field probability of detection for response and discrimination stages versus their respective background alarm rate for all ordnance larger than 20 mm.

N/A

Figure 10. MAG Sensor open field probability of detection for response and discrimination stages versus their respective probability of false positive for all ordnance larger than 20 mm.

N/A

Figure 11. MAG Sensor open field probability of detection for response and discrimination stages versus their respective background alarm rate for all ordnance larger than 20 mm.

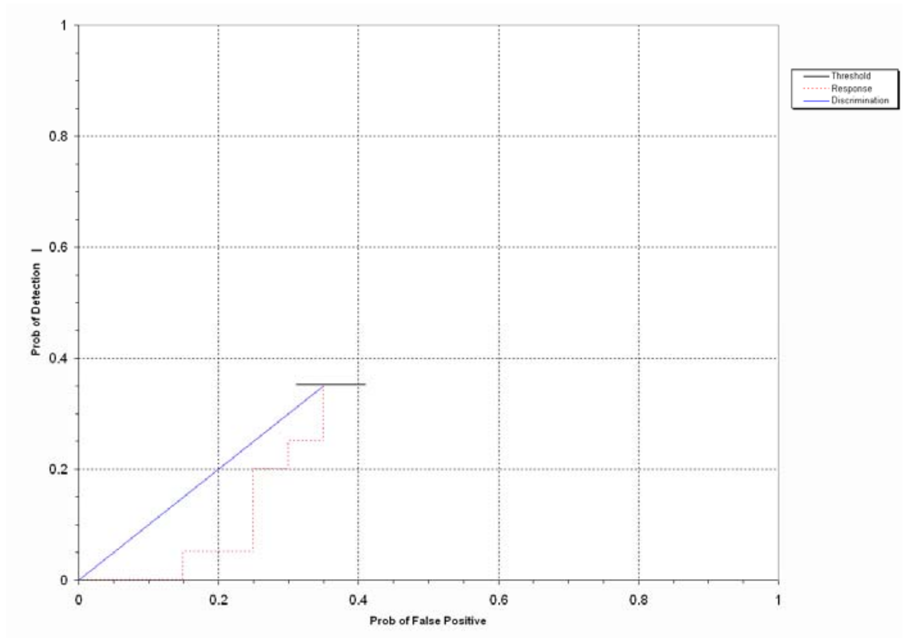

Figure 12. Combined Sensor open field probability of detection for response and discrimination stages versus their respective probability of false positive for all ordnance larger than 20 mm.

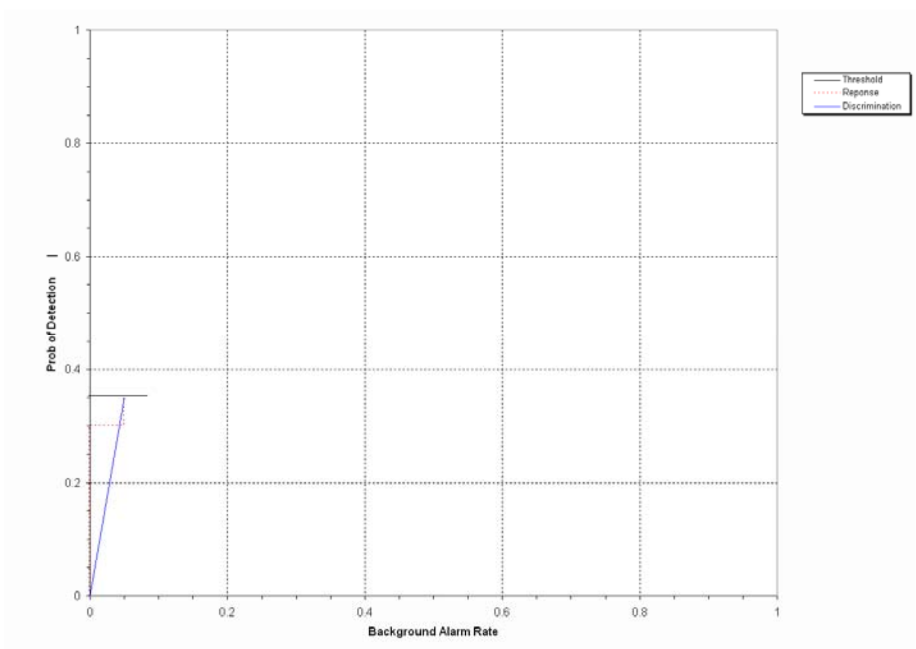

Figure 13. Combined Sensor open field probability of detection for response and discrimination stages versus their respective background alarm rate for all ordnance larger than 20 mm.

4.3 PERFORMANCE SUMMARIES

Results for the open field test broken out by sensor type, size, depth and nonstandard ordnance are presented in Table 5a, b, and c (for cost results, see section 5). Results by size and depth include both standard and nonstandard ordnance. The results by size show how well the demonstrator did at detecting/discriminating ordnance of a certain caliber range. Size definitions are provided in Appendix A. The results are relative to the number of ordnance items emplaced. Depth is measured from the geometric center of anomalies.

The RESPONSE STAGE results are derived from the list of anomalies above the demonstrator-provided noise level. The results for the DISCRIMINATION STAGE are derived from the demonstrator's recommended threshold for optimizing UXO field cleanup by minimizing false digs and maximizing ordnance recovery. The lower 90-percent confidence limit on probability of detection and P_{fp} was calculated assuming that the number of detections and false positives are binomially distributed random variables. All results in Table 5 have been rounded to protect the ground truth. However, lower confidence limits were calculated using actual results.

The overall ground truth is composed of ferrous and non-ferrous anomalies. Due to limitations of the magnetometer, the non-ferrous items cannot be detected. Therefore, the summary presented in Table 5b is split exhibiting results based on the subset of the ground truth that is solely the ferrous anomalies and the full ground truth for comparison purposes.

All other tables presented in this section are based on scoring against the ferrous only ground truth. The response stage noise level and recommended discrimination stage threshold values are provided by the demonstrator.

TABLE 5a. SUMMARY OF OPEN FIELD RESULTS FOR THE SAM DUAL MODE (EM sensor)

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
RESPONSE STAGE									
P_d	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Low 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Upper 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{fp}	N/A	-	-	-	-	-	N/A	N/A	N/A
P_{fp} Low 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
P_{fp} Upper 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
BAR	N/A	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Low 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Upper 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{fp}	N/A	-	-	-	-	-	N/A	N/A	N/A
P_{fp} Low 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
P_{fp} Upper 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
BAR	N/A	-	-	-	-	-	-	-	-

Response Stage Noise Level: N/A.
Recommended Discrimination Stage Threshold: N/A.

TABLE 5b. SUMMARY OF OPEN FIELD RESULTS FOR THE SAM DUAL MODE (MAG sensor)

Ferrous Only Ground Truth									
				By Size			By Depth, m		
Metric	**Overall**	**Standard**	**Nonstandard**	**Small**	**Medium**	**Large**	**< 0.3**	**0.3 to <1**	**>= 1**
RESPONSE STAGE									
P_d	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Low 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Upper 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{fp}	N/A	-	-	-	-	-	N/A	N/A	N/A
P_{fp} Low 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
P_{fp} Upper 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
BAR	N/A	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Low 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Upper 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{fp}	N/A	-	-	-	-	-	N/A	N/A	N/A
P_{fp} Low 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
P_{fp} Upper 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
BAR	N/A	-	-	-	-	-	-	-	-

Full Ground Truth									
				By Size			By Depth, m		
Metric	**Overall**	**Standard**	**Nonstandard**	**Small**	**Medium**	**Large**	**< 0.3**	**0.3 to <1**	**>= 1**
RESPONSE STAGE									
P_d	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Low 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Upper 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{fp}	N/A	-	-	-	-	-	N/A	N/A	N/A
P_{fp} Low 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
P_{fp} Upper 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
BAR	N/A	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Low 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_d Upper 90% Conf	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P_{fp}	N/A	-	-	-	-	-	N/A	N/A	N/A
P_{fp} Low 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
P_{fp} Upper 90% Conf	N/A	-	-	-	-	-	N/A	N/A	-
BAR	N/A	-	-	-	-	-	-	-	-

Response Stage Noise Level: N/A.
Recommended Discrimination Stage Threshold: N/A.

TABLE 5c. SUMMARY OF OPEN FIELD RESULTS FOR THE SAM DUAL MODE (combined EM/MAG results)

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
RESPONSE STAGE									
P_d	0.30	0.35	0.30	0.10	0.35	0.65	0.30	0.35	0.40
P_d Low 90% Conf	0.28	0.29	0.24	0.08	0.30	0.58	0.24	0.29	0.30
P_d Upper 90% Conf	0.35	0.37	0.34	0.15	0.40	0.73	0.32	0.42	0.47
P_{fp}	0.35	-	-	-	-	-	0.30	0.45	0.55
P_{fp} Low 90% Conf	0.34	-	-	-	-	-	0.27	0.41	0.38
P_{fp} Upper 90% Conf	0.38	-	-	-	-	-	0.32	0.47	0.74
BAR	0.05	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	0.30	0.35	0.30	0.10	0.35	0.65	0.30	0.35	0.40
P_d Low 90% Conf	0.28	0.29	0.24	0.08	0.30	0.58	0.24	0.29	0.30
P_d Upper 90% Conf	0.35	0.37	0.34	0.15	0.40	0.73	0.32	0.42	0.47
P_{fp}	0.35	-	-	-	-	-	0.30	0.45	0.55
P_{fp} Low 90% Conf	0.34	-	-	-	-	-	0.27	0.41	0.38
P_{fp} Upper 90% Conf	0.38	-	-	-	-	-	0.32	0.47	0.74
BAR	0.05	-	-	-	-	-	-	-	-

Response Stage Noise Level: 0.00.
Recommended Discrimination Stage Threshold: 0.50.

Note: The recommended discrimination stage threshold values are provided by the demonstrator.

4.4 EFFICIENCY, REJECTION RATES, AND TYPE CLASSIFICATION (All results based on combined EM/MAG data set)

Efficiency and rejection rates are calculated to quantify the discrimination ability at specific points of interest on the ROC curve: (1) at the point where no decrease in P_d is suffered (i.e., the efficiency is by definition equal to one) and (2) at the operator-selected threshold. These values are reported in Table 6.

TABLE 6. EFFICIENCY AND REJECTION RATES

	Efficiency (E)	False Positive Rejection Rate	Background Alarm Rejection Rate
At Operating Point	1.00	0.00	0.00
With No Loss of P_d	1.00	0.00	0.00

At the demonstrator's recommended setting, the ordnance items that were detected and correctly discriminated were further scored on whether their correct type could be identified (table 7). Correct type examples include 20-mm projectile, 105-mm HEAT Projectile, and 2.75-inch rocket. A list of the standard type declaration required for each ordnance item was provided to demonstrators prior to testing. For example, the standard type for the three example items are 20mmP, 105H, and 2.75in, respectively.

TABLE 7. CORRECT TYPE CLASSIFICATION OF TARGETS CORRECTLY DISCRIMINATED AS UXO

Size	Percentage Correct
Small	0.0
Medium	0.0
Large	0.0
Overall	0.0

Note: The demonstrator did not attempt to provide type classification.

4.5 LOCATION ACCURACY

The mean location error and standard deviations appear in Table 8. These calculations are based on average missed depth for ordnance correctly identified in the discrimination stage. Depths are measured from the closest point of the ordnance to the surface. For the blind grid, only depth errors are calculated because (X, Y) positions are known to be the centers of each grid square.

TABLE 8. MEAN LOCATION ERROR AND STANDARD DEVIATION (M)

	Mean	Standard Deviation
Northing	-0.08	0.21
Easting	0.03	0.19
Depth	-0.54	0.49

SECTION 5. ON-SITE LABOR COSTS

A standardized estimate for labor costs associated with this effort was calculated as follows: the first person at the test site was designated "supervisor," the second person was designated "data analyst," and the third and following personnel were considered "field support." Standardized hourly labor rates were charged by title: supervisor at $95.00/hour, data analyst at $57.00/hour, and field support at $28.50/hour.

Government representatives monitored on-site activity. All on-site activities were grouped into one of ten categories: initial setup/mobilization, daily setup/stop, calibration, data collection, downtime due to break/lunch, downtime due to equipment failure, downtime due to equipment/data checks or maintenance, downtime due to weather, downtime due to demonstration site issue, or demobilization. See Appendix D for the daily activity log. See section 3.4 for a summary of field activities.

The standardized cost estimate associated with the labor needed to perform the field activities is presented in Table 9. Note that calibration time includes time spent in the Calibration Lanes as well as field calibrations. "Site survey time" includes daily setup/stop time, collecting data, breaks/lunch, downtime due to equipment/data checks or maintenance, downtime due to failure, and downtime due to weather.

TABLE 9. ON-SITE LABOR COSTS

	No. of People	Hourly Wage	Hours	Cost
Initial setup				
Supervisor	1	$95.00	7.42	$704.90
Data Analyst	1	57.00	7.42	422.94
Field Support	2	28.50	7.42	422.94
Subtotal				**$1,550.78**
Calibration				
Supervisor	1	$95.00	14.08	$1,337.60
Data Analyst	1	57.00	14.08	802.56
Field Support	2	28.50	14.08	802.56
Subtotal				**$2,942.72**
Site survey				
Supervisor	1	$95.00	91.25	$8,668.75
Data Analyst	1	57.00	91.25	5201.25
Field Support	2	28.50	91.25	5201.25
Subtotal				**$19,071.25**

See notes at end of table.

TABLE 9 (CONT'D)

	No. of People	Hourly Wage	Hours	Cost
Demobilization				
Supervisor	1	$95.00	1.66	$157.70
Data Analyst	1	57.00	1.66	94.62
Field Support	2	28.50	1.66	94.62
Subtotal				346.94
Total				**$23,911.69**

Notes: Calibration time includes time spent in the calibration lanes as well as calibration before each data run.
Site Survey time includes daily setup/stop time, data collection, breaks/lunch, and downtime due to system maintenance, failure, and weather.

SECTION 6. COMPARISON OF RESULTS TO BLIND GRID DEMONSTRATION (BASED ON COMBINED EM/MAG DATA SETS)

6.1 SUMMARY OF RESULTS FROM BLIND GRID DEMONSTRATION

Table 10 shows the results from the blind grid survey conducted prior to surveying the open field during the same site visit in June 2008. Because the system uses magnetometer type sensors, all results presented in the following section have been based on performance scoring against the ferrous only ground truth anomalies. For more details on the blind grid survey results reference section 2.1.6.

TABLE 10. SUMMARY OF BLIND GRID RESULTS FOR THE SAM DUAL MODE

Metric	Overall	Standard	Nonstandard	By Size			By Depth, m		
				Small	Medium	Large	< 0.3	0.3 to <1	>= 1
RESPONSE STAGE									
P_d	0.60	0.70	0.50	0.40	0.80	1.00	0.55	0.65	0.65
P_d Low 90% Conf	0.54	0.59	0.39	0.29	0.67	0.79	0.45	0.54	0.43
P_d Upper 90% Conf	0.69	0.77	0.63	0.50	0.88	1.00	0.69	0.76	0.79
P_{fp}	0.75	-	-	-	-	-	0.75	0.80	0.65
P_{fp} Low 90% Conf	0.70	-	-	-	-	-	0.63	0.71	0.33
P_d Upper 90% Conf	0.82	-	-	-	-	-	0.83	0.87	0.91
P_{ba}	0.05	-	-	-	-	-	-	-	-
DISCRIMINATION STAGE									
P_d	0.60	0.70	0.50	0.40	0.80	1.00	0.55	0.65	0.65
P_d Low 90% Conf	0.54	0.59	0.39	0.29	0.67	0.79	0.45	0.54	0.43
P_d Upper 90% Conf	0.69	0.77	0.63	0.50	0.88	1.00	0.69	0.76	0.79
P_{fp}	0.75	-	-	-	-	-	0.75	0.80	0.65
P_{fp} Low 90% Conf	0.70	-	-	-	-	-	0.63	0.71	0.33
P_d Upper 90% Conf	0.82	-	-	-	-	-	0.83	0.87	0.91
P_{ba}	0.05	-	-	-	-	-	-	-	-

6.2 COMPARISON OF ROC CURVES USING ALL ORDNANCE CATEGORIES

Figure 6 shows P_d^{res} versus the respective P_{fp} over all ordnance categories. Figure 7 shows P_d^{disc} versus their respective P_{fp} over all ordnance categories. Figure 7 uses horizontal lines to illustrate the performance of the demonstrator at the recommended discrimination threshold levels, defining the subset of targets the demonstrator would recommend digging based on discrimination. The ROC curves in this section are a sole reflection of the ferrous only survey.

N/A

Figure 6. MAG sensor P_d^{res} stages versus the respective P_{fp} over all ordnance categories combined.

N/A

Figure 7. MAG sensor P_d^{disc} versus the respective P_{fp} over all ordnance categories combined.

6.3 COMPARISON OF ROC CURVES USING ORDNANCE LARGER THAN 20 MM

Figure 8 shows the P_d^{res} versus the respective probability of P_{fp} over ordnance larger than 20 mm. Figure 9 shows P_d^{disc} versus the respective P_{fp} over ordnance larger than 20 mm. Figure 9 uses horizontal lines to illustrate the performance of the demonstrator at the recommended discrimination threshold levels, defining the subset of targets the demonstrator would recommend digging based on discrimination.

N/A

Figure 8. MAG sensor P_d^{res} versus the respective P_{fp} for ordnance larger than 20 mm.

N/A

Figure 9. MAG sensor P_d^{disc} versus the respective P_{fp} for ordnance larger than 20 mm.

6.4 STATISTICAL COMPARISONS

Statistical Chi-square significance tests were used to compare results between the BLIND GRID and OPEN FIELD scenarios. The intent of the comparison is to determine if the feature introduced in each scenario has a degrading effect on the performance of the sensor system. However, any modifications in the UXO sensor system during the test, like changes in the processing or changes in the selection of the operating threshold, will also contribute to performance differences.

The Chi-square test for comparison between ratios was used at a significance level of 0.05 to compare blind grid to open field with regard to P_d^{res}, P_d^{disc}, P_{fp}^{res} and P_{fp}^{disc}, Efficiency and Rejection Rate. These results are presented in Table 11. A detailed explanation and example of the Chi-square application is located in Appendix A.

TABLE 11. CHI-SQUARE RESULTS - BLIND GRID VERSUS OPEN FIELD

Metric	Small	Medium	Large	Overall
P_d^{res}	Not Significant	Not Significant	Not Significant	Significant
P_d^{disc}	Not Significant	Not Significant	Not Significant	Significant
P_{fp}^{res}				Significant
P_{fp}^{disc}	-	-	-	Significant
Efficiency	-			Not Significant
Rejection Rate	-	-	-	Not Significant

<u>SECTION 7. APPENDIXES</u>

APPENDIX A. TERMS AND DEFINITIONS

GENERAL DEFINITIONS

Anomaly: Location of a system response deemed to warrant further investigation by the demonstrator for consideration as an emplaced ordnance item.

Detection: An anomaly location that is within R_{halo} of an emplaced ordnance item.

Munitions and Explosives Of Concern (MEC): Specific categories of military munitions that may pose unique explosive safety risks, including UXO as defined in 10 USC 101(e)(5), DMM as defined in 10 USC 2710(e)(2) and/or munitions constituents (e.g. TNT, RDX) as defined in 10 USC 2710(e)(3) that are present in high enough concentrations to pose an explosive hazard.

Emplaced Ordnance: An ordnance item buried by the government at a specified location in the test site.

Emplaced Clutter: A clutter item (i.e., non-ordnance item) buried by the government at a specified location in the test site.

R_{halo}: A pre-determined radius about the periphery of an emplaced item (clutter or ordnance) within which a location identified by the demonstrator as being of interest is considered to be a response from that item. If multiple declarations lie within R_{halo} of any item (clutter or ordnance), the declaration with the highest signal output within the R_{halo} will be utilized. For the purpose of this program, a circular halo 0.5 meters in radius will be placed around the center of the object for all clutter and ordnance items less than 0.6 meters in length. When ordnance items are longer than 0.6 meters, the halo becomes an ellipse where the minor axis remains 1 meter and the major axis is equal to the length of the ordnance plus 1 meter.

Small Ordnance: Caliber of ordnance less than or equal to 40 mm (includes 20-mm projectile, 40-mm projectile, submunitions BLU-26, BLU-63, and M42).

Medium Ordnance: Caliber of ordnance greater than 40 mm and less than or equal to 81 mm (includes 57-mm projectile, 60-mm mortar, 2.75 in. Rocket, MK118 Rockeye, 81-mm mortar).

Large Ordnance: Caliber of ordnance greater than 81 mm (includes 105-mm HEAT, 105-mm projectile, 155-mm projectile, 500-pound bomb).

Shallow: Items buried less than 0.3 meter below ground surface.

Medium: Items buried greater than or equal to 0.3 meter and less than 1 meter below ground surface.

Deep: Items buried greater than or equal to 1 meter below ground surface.

Response Stage Noise Level: The level that represents the point below which anomalies are not considered detectable. Demonstrators are required to provide the recommended noise level for the blind grid test area.

Discrimination Stage Threshold: The demonstrator selected threshold level that they believe provides optimum performance of the system by retaining all detectable ordnance and rejecting the maximum amount of clutter. This level defines the subset of anomalies the demonstrator would recommend digging based on discrimination.

Binomially Distributed Random Variable: A random variable of the type which has only two possible outcomes, say success and failure, is repeated for n independent trials with the probability p of success and the probability 1-p of failure being the same for each trial. The number of successes x observed in the n trials is an estimate of p and is considered to be a binomially distributed random variable.

RESPONSE AND DISCRIMINATION STAGE DATA

The scoring of the demonstrator's performance is conducted in two stages. These two stages are termed the RESPONSE STAGE and DISCRIMINATION STAGE. For both stages, the probability of detection (P_d) and the false alarms are reported as receiver operating characteristic (ROC) curves. False alarms are divided into those anomalies that correspond to emplaced clutter items, measuring the probability of false positive (P_{fp}) and those that do not correspond to any known item, termed background alarms.

The RESPONSE STAGE scoring evaluates the ability of the system to detect emplaced targets without regard to ability to discriminate ordnance from other anomalies. For the RESPONSE STAGE, the demonstrator provides the scoring committee with the location and signal strength of all anomalies that the demonstrator has deemed sufficient to warrant further investigation and/or processing as potential emplaced ordnance items. This list is generated with minimal processing (e.g., this list will include all signals above the system noise threshold). As such, it represents the most inclusive list of anomalies.

The DISCRIMINATION STAGE evaluates the demonstrator's ability to correctly identify ordnance as such, and to reject clutter. For the same locations as in the RESPONSE STAGE anomaly list, the DISCRIMINATION STAGE list contains the output of the algorithms applied in the discrimination-stage processing. This list is prioritized based on the demonstrator's determination that an anomaly location is likely to contain ordnance. Thus, higher output values are indicative of higher confidence that an ordnance item is present at the specified location. For electronic signal processing, priority ranking is based on algorithm output. For other systems, priority ranking is based on human judgment. The demonstrator also selects the threshold that the demonstrator believes will provide "optimum" system performance, (i.e., that retains all the detected ordnance and rejects the maximum amount of clutter).

Note: The two lists provided by the demonstrator contain identical numbers of potential target locations. They differ only in the priority ranking of the declarations.

RESPONSE STAGE DEFINITIONS

Response Stage Probability of Detection (P_d^{res}): P_d^{res} = (No. of response-stage detections)/(No. of emplaced ordnance in the test site).

Response Stage False Positive (fp^{res}): An anomaly location that is within R_{halo} of an emplaced clutter item.

Response Stage Probability of False Positive (P_{fp}^{res}): P_{fp}^{res} = (No. of response-stage false positives)/(No. of emplaced clutter items).

Response Stage Background Alarm (ba^{res}): An anomaly in a blind grid cell that contains neither emplaced ordnance nor an emplaced clutter item. An anomaly location in the open field or scenarios that is outside R_{halo} of any emplaced ordnance or emplaced clutter item.

Response Stage Probability of Background Alarm (P_{ba}^{res}): Blind Grid only: P_{ba}^{res} = (No. of response-stage background alarms)/(No. of empty grid locations).

Response Stage Background Alarm Rate (BAR^{res}): Open Field only: BAR^{res} = (No. of response-stage background alarms)/(arbitrary constant).

Note that the quantities P_d^{res}, P_{fp}^{res}, P_{ba}^{res}, and BAR^{res} are functions of t^{res}, the threshold applied to the response-stage signal strength. These quantities can therefore be written as $P_d^{res}(t^{res})$, $P_{fp}^{res}(t^{res})$, $P_{ba}^{res}(t^{res})$, and $BAR^{res}(t^{res})$.

DISCRIMINATION STAGE DEFINITIONS

Discrimination: The application of a signal processing algorithm or human judgment to response-stage data that discriminates ordnance from clutter. Discrimination should identify anomalies that the demonstrator has high confidence correspond to ordnance, as well as those that the demonstrator has high confidence correspond to non-ordnance or background returns. The former should be ranked with highest priority and the latter with lowest.

Discrimination Stage Probability of Detection (P_d^{disc}): P_d^{disc} = (No. of discrimination-stage detections)/(No. of emplaced ordnance in the test site).

Discrimination Stage False Positive (fp^{disc}): An anomaly location that is within R_{halo} of an emplaced clutter item.

Discrimination Stage Probability of False Positive (P_{fp}^{disc}): P_{fp}^{disc} = (No. of discrimination stage false positives)/(No. of emplaced clutter items).

Discrimination Stage Background Alarm (ba^{disc}): An anomaly in a blind grid cell that contains neither emplaced ordnance nor an emplaced clutter item. An anomaly location in the open field or scenarios that is outside R_{halo} of any emplaced ordnance or emplaced clutter item.

Discrimination Stage Probability of Background Alarm (P_{ba}^{disc}): P_{ba}^{disc} = (No. of discrimination-stage background alarms)/(No. of empty grid locations).

Discrimination Stage Background Alarm Rate (BAR^{disc}): BAR^{disc} = (No. of discrimination-stage background alarms)/(arbitrary constant).

Note that the quantities P_d^{disc}, P_{fp}^{disc}, P_{ba}^{disc}, and BAR^{disc} are functions of t^{disc}, the threshold applied to the discrimination-stage signal strength. These quantities can therefore be written as $P_d^{disc}(t^{disc})$, $P_{fp}^{disc}(t^{disc})$, $P_{ba}^{disc}(t^{disc})$, and $BAR^{disc}(t^{disc})$.

RECEIVER-OPERATING CHARACERISTIC (ROC) CURVES

ROC curves at both the response and discrimination stages can be constructed based on the above definitions. The ROC curves plot the relationship between P_d versus P_{fp} and P_d versus BAR or P_{ba} as the threshold applied to the signal strength is varied from its minimum (t_{min}) to its maximum (t_{max}) value.[1] Figure A-1 shows how P_d versus P_{fp} and P_d versus BAR are combined into ROC curves. Note that the "res" and "disc" superscripts have been suppressed from all the variables for clarity.

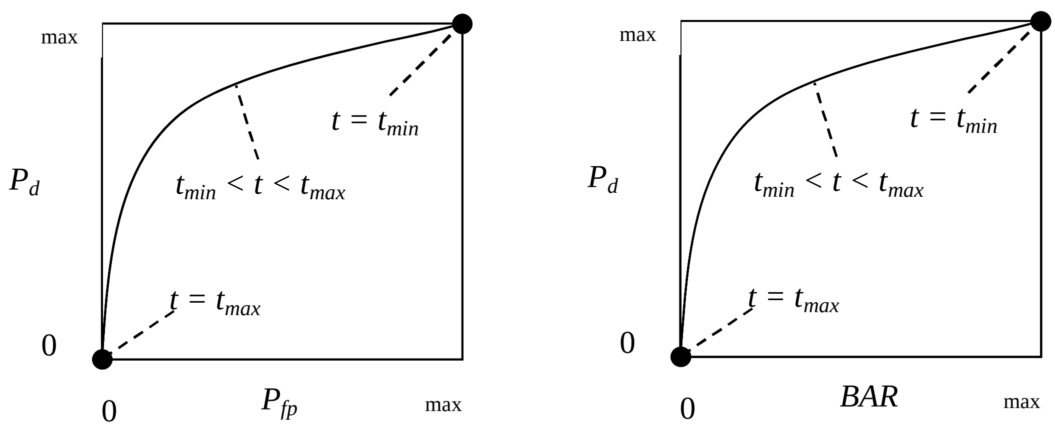

Figure A-1. ROC curves for open field testing. Each curve applies to both the response and discrimination stages.

[1]Strictly speaking, ROC curves plot the P_d versus P_{ba} over a pre-determined and fixed number of detection opportunities (some of the opportunities are located over ordnance and others are located over clutter or blank spots). In an open field scenario, each system suppresses its signal strength reports until some bare-minimum signal response is received by the system. Consequently, the open field ROC curves do not have information from low signal-output locations, and, furthermore, different contractors report their signals over a different set of locations on the ground. These ROC curves are thus not true to the strict definition of ROC curves as defined in textbooks on detection theory. Note, however, that the ROC curves obtained in the blind grid test sites are true ROC curves.

METRICS TO CHARACTERIZE THE DISCRIMINATION STAGE

The demonstrator is also scored on efficiency and rejection ratio, which measure the effectiveness of the discrimination stage processing. The goal of discrimination is to retain the greatest number of ordnance detections from the anomaly list, while rejecting the maximum number of anomalies arising from non-ordnance items. The efficiency measures the amount of detected ordnance retained by the discrimination, while the rejection ratio measures the fraction of false alarms rejected. Both measures are defined relative to the entire response list, i.e., the maximum ordnance detectable by the sensor and its accompanying false positive rate or background alarm rate.

Efficiency (E): $E = P_d^{disc}(t^{disc})/P_d^{res}(t_{min}^{res})$; Measures (at a threshold of interest), the degree to which the maximum theoretical detection performance of the sensor system (as determined by the response stage t_{min}) is preserved after application of discrimination techniques. Efficiency is a number between 0 and 1. An efficiency of 1 implies that all of the ordnance initially detected in the response stage was retained at the specified threshold in the discrimination stage, t^{disc}.

False Positive Rejection Rate (R_{fp}): $R_{fp} = 1 - [P_{fp}^{disc}(t^{disc})/P_{fp}^{res}(t_{min}^{res})]$; Measures (at a threshold of interest), the degree to which the sensor system's false positive performance is improved over the maximum false positive performance (as determined by the response stage tmin). The rejection rate is a number between 0 and 1. A rejection rate of 1 implies that all emplaced clutter initially detected in the response stage were correctly rejected at the specified threshold in the discrimination stage.

Background Alarm Rejection Rate (R_{ba}):

Blind Grid: $R_{ba} = 1 - [P_{ba}^{disc}(t^{disc})/P_{ba}^{res}(t_{min}^{res})]$.
Open Field: $R_{ba} = 1 - [BAR^{disc}(t^{disc})/BAR^{res}(t_{min}^{res})])$.

Measures the degree to which the discrimination stage correctly rejects background alarms initially detected in the response stage. The rejection rate is a number between 0 and 1. A rejection rate of 1 implies that all background alarms initially detected in the response stage were rejected at the specified threshold in the discrimination stage.

CHI-SQUARE COMPARISON EXPLANATION:

The Chi-square test for differences in probabilities (or 2 x 2 contingency table) is used to analyze two samples drawn from two different populations to see if both populations have the same or different proportions of elements in a certain category. More specifically, two random samples are drawn, one from each population, to test the null hypothesis that the probability of event A (some specified event) is the same for both populations (ref 3).

A 2 x 2 contingency table is used in the Standardized UXO Technology Demonstration Site Program to determine if there is reason to believe that the proportion of ordnance correctly detected/discriminated by demonstrator X’s system is significantly degraded by the more challenging terrain feature introduced. The test statistic of the 2 x 2 contingency table is the

Chi-square distribution with one degree of freedom. Since an association between the more challenging terrain feature and relatively degraded performance is sought, a one-sided test is performed. A significance level of 0.05 is chosen which sets a critical decision limit of 2.71 from the Chi-square distribution with one degree of freedom. It is a critical decision limit because if the test statistic calculated from the data exceeds this value, the two proportions tested will be considered significantly different. If the test statistic calculated from the data is less than this value, the two proportions tested will be considered not significantly different.

An exception must be applied when either a 0 or 100 percent success rate occurs in the sample data. The Chi-square test cannot be used in these instances. Instead, Fischer's test is used and the critical decision limit for one-sided tests is the chosen significance level, which in this case is 0.05. With Fischer's test, if the test statistic is less than the critical value, the proportions are considered to be significantly different.

Standardized UXO Technology Demonstration Site examples, where blind grid results are compared to those from the open field and open field results are compared to those from one of the scenarios, follow. It should be noted that a significant result does not prove a cause and effect relationship exists between the two populations of interest; however, it does serve as a tool to indicate that one data set has experienced a degradation in system performance at a large enough level than can be accounted for merely by chance or random variation. Note also that a result that is not significant indicates that there is not enough evidence to declare that anything more than chance or random variation within the same population is at work between the two data sets being compared.

Demonstrator X achieves the following overall results after surveying each of the three progressively more difficult areas using the same system (results indicate the number of ordnance detected divided by the number of ordnance emplaced):

	Blind grid	Open field	Moguls
P_d^{res}	100/100 = 1.0	8/10 = .80	20/33 = .61
P_d^{disc}	80/100 = 0.80	6/10 = .60	8/33 = .24

P_d^{res}: BLIND GRID versus OPEN FIELD. Using the example data above to compare probabilities of detection in the response stage, all 100 ordnance out of 100 emplaced ordnance items were detected in the blind grid while 8 ordnance out of 10 emplaced were detected in the open field. Fischer's test must be used since a 100 percent success rate occurs in the data. Fischer's test uses the four input values to calculate a test statistic of 0.0075 that is compared against the critical value of 0.05. Since the test statistic is less than the critical value, the smaller response stage detection rate (0.80) is considered to be significantly less at the 0.05 level of significance. While a significant result does not prove a cause and effect relationship exists between the change in survey area and degradation in performance, it does indicate that the detection ability of demonstrator X's system seems to have been degraded in the open field relative to results from the blind grid using the same system.

P_d^{disc}: BLIND GRID versus OPEN FIELD. Using the example data above to compare probabilities of detection in the discrimination stage, 80 out of 100 emplaced ordnance items were correctly discriminated as ordnance in blind grid testing while 6 ordnance out of 10 emplaced were correctly discriminated as such in open field-testing. Those four values are used to calculate a test statistic of 1.12. Since the test statistic is less than the critical value of 2.71, the two discrimination stage detection rates are considered to be not significantly different at the 0.05 level of significance.

P_d^{res}: OPEN FIELD versus MOGULS. Using the example data above to compare probabilities of detection in the response stage, 8 out of 10 and 20 out of 33 are used to calculate a test statistic of 0.56. Since the test statistic is less than the critical value of 2.71, the two response stage detection rates are considered to be not significantly different at the 0.05 level of significance.

P_d^{disc}: OPEN FIELD versus MOGULS. Using the example data above to compare probabilities of detection in the discrimination stage, 6 out of 10 and 8 out of 33 are used to calculate a test statistic of 2.98. Since the test statistic is greater than the critical value of 2.71, the smaller discrimination stage detection rate is considered to be significantly less at the 0.05 level of significance. While a significant result does not prove a cause and effect relationship exists between the change in survey area and degradation in performance, it does indicate that the ability of demonstrator X to correctly discriminate seems to have been degraded by the mogul terrain relative to results from the flat open field using the same system.

APPENDIX B. DAILY WEATHER LOGS

Date	Time, Eastern Standard Time (EST)	Average Temperature, ^{o}F	Total Precipitation, in.
6/8/2007	07:00	71.1	0.00
6/8/2007	08:00	74.3	0.00
6/8/2007	09:00	78.4	0.00
6/8/2007	10:00	82.2	0.00
6/8/2007	11:00	86.0	0.00
6/8/2007	12:00	88.3	0.00
6/8/2007	13:00	88.3	0.00
6/8/2007	14:00	90.5	0.00
6/8/2007	15:00	92.1	0.00
6/8/2007	16:00	92.7	0.00
6/8/2007	17:00	91.8	0.00
6/9/2007	07:00	76.1	0.00
6/9/2007	08:00	76.6	0.00
6/9/2007	09:00	77.4	0.00
6/9/2007	10:00	80.1	0.00
6/9/2007	11:00	81.7	0.00
6/9/2007	12:00	83.1	0.00
6/9/2007	13:00	83.7	0.00
6/9/2007	14:00	83.7	0.00
6/9/2007	15:00	83.8	0.00
6/9/2007	16:00	84.4	0.00
6/9/2007	17:00	83.7	0.00
6/10/2007	07:00	68.5	0.00
6/10/2007	08:00	70.2	0.00
6/10/2007	09:00	70.7	0.00
6/10/2007	10:00	70.5	0.00
6/10/2007	11:00	70.9	0.00
6/10/2007	12:00	71.8	0.00
6/10/2007	13:00	72.5	0.00
6/10/2007	14:00	72.5	0.00
6/10/2007	15:00	73.4	0.00
6/10/2007	16:00	75.4	0.00
6/10/2007	17:00	76.6	0.00

Date	**Time, Eastern Standard Time (EST)**	**Average Temperature, °F**	**Total Precipitation, in.**
6/11/2007	07:00	66.0	0.00
6/11/2007	08:00	69.6	0.00
6/11/2007	09:00	72.7	0.00
6/11/2007	10:00	75.9	0.00
6/11/2007	11:00	79.2	0.00
6/11/2007	12:00	77.2	0.00
6/11/2007	13:00	80.2	0.00
6/11/2007	14:00	78.8	0.00
6/11/2007	15:00	81.5	0.00
6/11/2007	16:00	82.4	0.00
6/11/2007	17:00	82.8	0.00
6/12/2007	07:00	70.3	0.00
6/12/2007	08:00	73.4	0.00
6/12/2007	09:00	78.3	0.00
6/12/2007	10:00	80.8	0.00
6/12/2007	11:00	82.2	0.00
6/12/2007	12:00	83.7	0.00
6/12/2007	13:00	85.8	0.00
6/12/2007	14:00	86.4	0.00
6/12/2007	15:00	87.1	0.00
6/12/2007	16:00	73.0	0.01
6/12/2007	17:00	70.0	0.07
6/13/2007	07:00	66.2	0.00
6/13/2007	08:00	70.9	0.00
6/13/2007	09:00	73.6	0.00
6/13/2007	10:00	75.7	0.00
6/13/2007	11:00	77.4	0.00
6/13/2007	12:00	77.7	0.00
6/13/2007	13:00	79.5	0.00
6/13/2007	14:00	79.0	0.00
6/13/2007	15:00	76.5	0.00
6/13/2007	16:00	72.0	0.01
6/13/2007	17:00	68.4	0.00

Date	Time, Eastern Standard Time (EST)	Average Temperature, ^{o}F	Total Precipitation, in.
6/14/2007	07:00	59.0	0.00
6/14/2007	08:00	59.2	0.00
6/14/2007	09:00	60.6	0.00
6/14/2007	10:00	62.2	0.00
6/14/2007	11:00	63.1	0.00
6/14/2007	12:00	64.8	0.00
6/14/2007	13:00	64.9	0.00
6/14/2007	14:00	64.6	0.00
6/14/2007	15:00	65.1	0.00
6/14/2007	16:00	64.8	0.00
6/14/2007	17:00	63.9	0.00
6/15/2007	07:00	60.8	0.00
6/15/2007	08:00	63.9	0.00
6/15/2007	09:00	65.8	0.00
6/15/2007	10:00	66.7	0.00
6/15/2007	11:00	69.1	0.00
6/15/2007	12:00	69.3	0.00
6/15/2007	13:00	70.2	0.00
6/15/2007	14:00	71.2	0.00
6/15/2007	15:00	72.3	0.00
6/15/2007	16:00	72.1	0.00
6/15/2007	17:00	70.9	0.00
6/16/2007	07:00	63.3	0.00
6/16/2007	08:00	66.4	0.00
6/16/2007	09:00	70.9	0.00
6/16/2007	10:00	73.8	0.00
6/16/2007	11:00	76.3	0.00
6/16/2007	12:00	77.0	0.00
6/16/2007	13:00	77.9	0.00
6/16/2007	14:00	78.8	0.00
6/16/2007	15:00	78.8	0.00
6/16/2007	16:00	78.6	0.00
6/16/2007	17:00	78.6	0.00

Date	Time, Eastern Standard Time (EST)	Average Temperature, ^oF	Total Precipitation, in.
6/17/2007	07:00	68.4	0.00
6/17/2007	08:00	72.7	0.00
6/17/2007	09:00	76.8	0.00
6/17/2007	10:00	81.0	0.00
6/17/2007	11:00	84.7	0.00
6/17/2007	12:00	86.4	0.00
6/17/2007	13:00	87.8	0.00
6/17/2007	14:00	88.5	0.00
6/17/2007	15:00	89.6	0.00
6/17/2007	16:00	89.2	0.00
6/17/2007	17:00	89.1	0.00
6/18/2007	07:00	73.9	0.00
6/18/2007	08:00	80.4	0.00
6/18/2007	09:00	83.5	0.00
6/18/2007	10:00	85.3	0.00
6/18/2007	11:00	86.7	0.00
6/18/2007	12:00	87.8	0.00
6/18/2007	13:00	88.3	0.00
6/18/2007	14:00	89.1	0.00
6/18/2007	15:00	89.6	0.00
6/18/2007	16:00	90.0	0.00
6/18/2007	17:00	89.8	0.00
6/19/2007	07:00	72.0	0.00
6/19/2007	08:00	74.7	0.00
6/19/2007	09:00	77.7	0.00
6/19/2007	10:00	80.8	0.00
6/19/2007	11:00	84.2	0.00
6/19/2007	12:00	86.5	0.00
6/19/2007	13:00	89.2	0.00
6/19/2007	14:00	90.7	0.00
6/19/2007	15:00	91.2	0.00
6/19/2007	16:00	91.6	0.00
6/19/2007	17:00	91.4	0.00

Date	Time, Eastern Standard Time (EST)	Average Temperature, ^oF	Total Precipitation, in.
6/20/2007	07:00	72.3	0.00
6/20/2007	08:00	70.3	0.00
6/20/2007	09:00	70.9	0.00
6/20/2007	10:00	73.2	0.00
6/20/2007	11:00	75.9	0.00
6/20/2007	12:00	77.2	0.00
6/20/2007	13:00	78.8	0.00
6/20/2007	14:00	79.2	0.00
6/20/2007	15:00	81.0	0.00
6/20/2007	16:00	81.7	0.00
6/20/2007	17:00	82.0	0.00
6/21/2007	07:00	63.3	0.00
6/21/2007	08:00	69.4	0.00
6/21/2007	09:00	74.3	0.00
6/21/2007	10:00	77.0	0.00
6/21/2007	11:00	79.2	0.00
6/21/2007	12:00	81.1	0.00
6/21/2007	13:00	82.8	0.00
6/21/2007	14:00	83.5	0.00
6/21/2007	15:00	84.4	0.00
6/21/2007	16:00	83.5	0.00
6/21/2007	17:00	85.5	0.00
6/22/2007	07:00	66.4	0.00
6/22/2007	08:00	69.4	0.00
6/22/2007	09:00	71.4	0.00
6/22/2007	10:00	73.9	0.00
6/22/2007	11:00	75.9	0.00
6/22/2007	12:00	76.5	0.00
6/22/2007	13:00	77.7	0.00
6/22/2007	14:00	78.4	0.00
6/22/2007	15:00	78.4	0.00
6/22/2007	16:00	79.0	0.00
6/22/2007	17:00	79.0	0.00

Date	Time, Eastern Standard Time (EST)	Average Temperature, ^{o}F	Total Precipitation, in.
6/23/2007	07:00	60.3	0.00
6/23/2007	08:00	66.6	0.00
6/23/2007	09:00	69.3	0.00
6/23/2007	10:00	71.2	0.00
6/23/2007	11:00	73.0	0.00
6/23/2007	12:00	74.3	0.00
6/23/2007	13:00	75.7	0.00
6/23/2007	14:00	77.5	0.00
6/23/2007	15:00	78.6	0.00
6/23/2007	16:00	79.0	0.00
6/23/2007	17:00	79.0	0.00
6/24/2007	07:00	65.3	0.00
6/24/2007	08:00	70.0	0.00
6/24/2007	09:00	72.5	0.00
6/24/2007	10:00	75.4	0.00
6/24/2007	11:00	77.0	0.00
6/24/2007	12:00	78.8	0.00
6/24/2007	13:00	80.2	0.00
6/24/2007	14:00	81.7	0.00
6/24/2007	15:00	82.8	0.00
6/24/2007	16:00	82.9	0.00
6/24/2007	17:00	82.9	0.00
6/25/2007	07:00	68.9	0.00
6/25/2007	08:00	69.4	0.00
6/25/2007	09:00	70.7	0.00
6/25/2007	10:00	73.8	0.00
6/25/2007	11:00	75.9	0.00
6/25/2007	12:00	79.3	0.00
6/25/2007	13:00	81.0	0.00
6/25/2007	14:00	82.0	0.00
6/25/2007	15:00	82.8	0.00
6/25/2007	16:00	83.8	0.00
6/25/2007	17:00	82.6	0.00

Date	Time, Eastern Standard Time (EST)	Average Temperature, ^{o}F	Total Precipitation, in.
6/26/2007	07:00	74.1	0.00
6/26/2007	08:00	76.6	0.00
6/26/2007	09:00	82.6	0.00
6/26/2007	10:00	85.5	0.00
6/26/2007	11:00	86.7	0.00
6/26/2007	12:00	87.6	0.00
6/26/2007	13:00	88.5	0.00
6/26/2007	14:00	89.6	0.00
6/26/2007	15:00	90.1	0.00
6/26/2007	16:00	90.0	0.00
6/26/2007	17:00	89.1	0.00
6/27/2007	07:00	76.5	0.00
6/27/2007	08:00	81.0	0.00
6/27/2007	09:00	84.0	0.00
6/27/2007	10:00	86.9	0.00
6/27/2007	11:00	88.7	0.00
6/27/2007	12:00	90.7	0.00
6/27/2007	13:00	90.9	0.00
6/27/2007	14:00	91.9	0.00
6/27/2007	15:00	91.4	0.00
6/27/2007	16:00	84.7	0.00
6/27/2007	17:00	82.6	0.00

APPENDIX C. SOIL MOISTURE

Date: 6/09/07			
Times: 1000 and 1600			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Wooded area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Calibration lanes	0 to 6	11.2	11.4
	6 to 12	15.9	15.7
	12 to 24	24.7	24.9
	24 to 36	28.9	28.8
	36 to 48	32.3	32.3
Blind grid/moguls	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Date: 6/11/07			
Times: 900 and 1430			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Wooded area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Calibration lanes	0 to 6	11.7	11.9
	6 to 12	15.8	15.5
	12 to 24	24.6	24.2
	24 to 36	29.8	29.1
	36 to 48	33.1	33.2
Blind grid/moguls	0 to 6	12.9	12.8
	6 to 12	10.7	10.6
	12 to 24	25.2	25.3
	24 to 36	19.4	19.1
	36 to 48	26.8	26.7

Date: 6/12/07			
Times: 1000 and 1435			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	55.4	55.3
	6 to 12	48.8	48.6
	12 to 24	69.7	69.4
	24 to 36	68.9	68.4
	36 to 48	72.0	71.7
Wooded area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6	38.5	38.4
	6 to 12	39.7	39.5
	12 to 24	45.0	44.9
	24 to 36	48.4	48.3
	36 to 48	49.5	49.6
Calibration lanes	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind grid/moguls	0 to 6	12.7	12.6
	6 to 12	10.8	10.4
	12 to 24	25.1	25.0
	24 to 36	18.5	18.3
	36 to 48	26.6	26.4

Date: 6/13/07			
Times: 1000 and 1400			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	55.2	55.0
	6 to 12	48.7	48.3
	12 to 24	69.6	69.7
	24 to 36	69.2	68.8
	36 to 48	72.3	71.9
Wooded area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6	38.6	38.3
	6 to 12	39.4	39.4
	12 to 24	44.7	44.6
	24 to 36	48.1	48.0
	36 to 48	49.3	49.2
Calibration lanes	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind grid/moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Date: 6/14/07			
Times: 1100 and 1500			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	54.8	54.7
	6 to 12	48.5	48.2
	12 to 24	69.3	69.1
	24 to 36	68.5	68.7
	36 to 48	71.7	71.6
Wooded area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6	38.5	38.2
	6 to 12	39.7	39.6
	12 to 24	44.8	44.4
	24 to 36	47.8	47.6
	36 to 48	49.1	49.0
Calibration lanes	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind grid/moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Date: 6/15/07			
Times: 1000 and 1530			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	54.6	54.4
	6 to 12	48.2	48.1
	12 to 24	68.9	68.8
	24 to 36	68.3	68.2
	36 to 48	71.5	71.6
Wooded area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6	38.1	37.9
	6 to 12	39.4	39.5
	12 to 24	44.3	44.4
	24 to 36	47.5	47.5
	36 to 48	48.8	48.7
Calibration lanes	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind grid/moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Date: 6/16/07			
Times: 0900 and 1430			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	54.2	54.1
	6 to 12	48.1	48.0
	12 to 24	68.9	68.8
	24 to 36	68.5	68.4
	36 to 48	71.2	71.1
Wooded area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6	37.8	37.8
	6 to 12	39.3	39.2
	12 to 24	44.2	44.1
	24 to 36	47.2	47.3
	36 to 48	48.5	48.4
Calibration lanes	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind grid/moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Date: 6/18/07			
Times: 0930 and 1445			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	53.8	53.9
	6 to 12	47.6	47.8
	12 to 24	68.5	68.4
	24 to 36	68.8	68.7
	36 to 48	71.8	71.7
Wooded area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6	37.6	37.7
	6 to 12	38.9	38.7
	12 to 24	44.6	44.5
	24 to 36	47.8	47.7
	36 to 48	48.6	48.7
Calibration lanes	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind grid/moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Date: 6/19/07			
Times: 1030 and 1500			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	53.6	53.5
	6 to 12	47.5	47.6
	12 to 24	68.7	68.6
	24 to 36	68.5	68.3
	36 to 48	71.9	71.8
Wooded area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6	37.8	37.5
	6 to 12	38.8	38.4
	12 to 24	44.3	44.4
	24 to 36	47.6	47.7
	36 to 48	48.5	48.8
Calibration lanes	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind grid/moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Date: 6/20/07			
Times: 0800 and 1300			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	53.4	53.3
	6 to 12	47.4	47.2
	12 to 24	68.9	68.8
	24 to 36	68.4	68.2
	36 to 48	71.6	71.5
Wooded area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6	37.7	37.6
	6 to 12	38.3	38.2
	12 to 24	44.6	44.2
	24 to 36	47.5	47.4
	36 to 48	48.3	48.2
Calibration lanes	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind grid/moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Date: 6/25/07			
Times: 0900 and 1330			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	53.1	53.1
	6 to 12	47.2	47.1
	12 to 24	68.7	68.6
	24 to 36	68.5	68.4
	36 to 48	71.3	71.2
Wooded area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6	37.4	37.3
	6 to 12	38.1	38.0
	12 to 24	44.5	44.3
	24 to 36	47.2	47.1
	36 to 48	48.1	48.0
Calibration lanes	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind grid/moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Date: 6/26/07			
Times: 0800 and 1500			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	52.8	52.6
	6 to 12	47.0	46.8
	12 to 24	68.4	68.5
	24 to 36	68.2	68.1
	36 to 48	71.1	71.0
Wooded area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6	37.2	37.1
	6 to 12	37.8	37.6
	12 to 24	44.2	44.0
	24 to 36	46.8	46.4
	36 to 48	47.8	47.6
Calibration lanes	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Blind grid/moguls	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		

Date: 6/27/07			
Times: 0800 and 1430			
Probe Location	**Layer, in.**	**A.M. Reading, %**	**P.M. Reading, %**
Wet area	0 to 6	N/A	
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Wooded area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Open area	0 to 6		
	6 to 12		
	12 to 24		
	24 to 36		
	36 to 48		
Calibration lanes	0 to 6	10.7	10.5
	6 to 12	14.9	14.7
	12 to 24	24.0	24.1
	24 to 36	27.2	27.1
	36 to 48	32.8	32.5
Blind grid/moguls	0 to 6	11.2	11.1
	6 to 12	9.8	9.6
	12 to 24	24.3	24.2
	24 to 36	18.1	17.9
	36 to 48	25.1	25.0

APPENDIX D. DAILY ACTIVITY LOG

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
6/8/2007	4	CALIBRATION LANES	1515	1700	105	INITIAL SETUP	INITIAL MOBILIZATION	GPS	NA	LINEAR	SUNNY	HOT
6/9/2007	4	CALIBRATION LANES	745	1250	305	INITIAL SETUP	INITIAL MOBILIZATION	GPS	NA	LINEAR	SUNNY	DRY
6/9/2007	4	CALIBRATION LANES	1250	1330	40	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	DRY
6/9/2007	4	CALIBRATION LANES	1330	1405	35	INITIAL SETUP	INITIAL MOBILIZATION	GPS	NA	LINEAR	SUNNY	DRY
6/9/2007	4	CALIBRATION LANES	1405	1415	10	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	SUNNY	DRY
6/9/2007	4	CALIBRATION LANES	1415	1430	15	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
6/9/2007	4	CALIBRATION LANES	1430	1505	35	DOWNTIME DUE TO EQUIPMENT FAILURE	FAULTY FUEL FILTER ON GENERATOR, REPLACED	GPS	NA	LINEAR	SUNNY	DRY
6/9/2007	4	CALIBRATION LANES	1505	1700	115	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
6/9/2007	4	CALIBRATION LANES	1700	1720	20	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	SUNNY	DRY
6/11/2007	4	CALIBRATION LANES	745	1030	165	DAILY START, STOP	SETUP	GPS	NA	LINEAR	SUNNY	DRY
6/11/2007	4	CALIBRATION LANES	1030	1145	75	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
6/11/2007	4	CALIBRATION LANES	1145	1210	25	DOWNTIME DUE TO EQUIPMENT MAINTENANCE CHECK	DATA, EQUIPMENT CHECK	GPS	NA	LINEAR	SUNNY	DRY
6/11/2007	4	CALIBRATION LANES	1210	1225	15	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
6/11/2007	4	CALIBRATION LANES	1225	1310	45	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	DRY
6/11/2007	4	BLIND TEST GRID	1310	1445	95	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
6/11/2007	4	BLIND TEST GRID	1445	1530	45	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
6/11/2007	4	BLIND TEST GRID	1530	1550	20	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	DRY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
6/11/2007	4	BLIND TEST GRID	1550	1630	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
6/11/2007	4	BLIND TEST GRID	1630	1655	25	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
6/11/2007	4	BLIND TEST GRID	1655	1520	-95	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	SUNNY	DRY
6/12/2007	4	BLIND TEST GRID	800	835	35	DAILY START, STOP	SETUP	GPS	NA	LINEAR	SUNNY	DRY
6/12/2007	4	BLIND TEST GRID	835	900	25	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	SUNNY	DRY
6/12/2007	4	BLIND TEST GRID	900	1040	100	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
6/12/2007	4	OPEN FIELD	1040	1145	65	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
6/12/2007	4	OPEN FIELD	1145	1240	55	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
6/12/2007	4	OPEN FIELD	1240	1335	55	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	DRY
6/12/2007	4	OPEN FIELD	1335	1400	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
6/12/2007	4	OPEN FIELD	1400	1425	25	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
6/12/2007	4	OPEN FIELD	1425	1520	55	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
6/12/2007	4	OPEN FIELD	1520	1550	30	WEATHER ISSUE	WEATHER ISSUE LIGHTNING WARNING	GPS	NA	LINEAR	RAINY	WET
6/13/2007	4	OPEN FIELD	1550	1610	20	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	RAINY	WET
6/13/2007	4	OPEN FIELD	755	950	115	DAILY START, STOP	SETUP	GPS	NA	LINEAR	SUNNY	WET
6/13/2007	4	OPEN FIELD	950	1045	55	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	WET
6/13/2007	4	OPEN FIELD	1045	1110	25	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	WET
6/13/2007	4	OPEN FIELD	1110	1225	75	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	WET

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
6/13/2007	4	OPEN FIELD	1225	1245	20	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	WET
6/13/2007	4	OPEN FIELD	1245	1330	45	WEATHER ISSUE	WEATHER ISSUE LIGHTNING WARNING	GPS	NA	LINEAR	SUNNY	WET
6/13/2007	4	OPEN FIELD	1330	1455	85	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	WET
6/13/2007	4	OPEN FIELD	1455	1510	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	WET
6/13/2007	4	OPEN FIELD	1510	1550	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	WET
6/13/2007	4	OPEN FIELD	1550	1605	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	WET
6/13/2007	4	OPEN FIELD	1605	1635	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	WET
6/13/2007	4	OPEN FIELD	1635	1705	30	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	SUNNY	WET
6/14/2007	4	OPEN FIELD	750	820	30	DAILY START, STOP	SETUP	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	820	830	10	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	830	845	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	845	1010	85	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1010	1025	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1025	1110	45	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1110	1130	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1130	1210	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1210	1305	55	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	CLOUDY	DRY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
6/14/2007	4	OPEN FIELD	1305	1400	55	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1400	1420	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1420	1450	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1450	1505	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1505	1540	35	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1540	1550	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1550	1625	35	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1625	1635	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1635	1655	20	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/14/2007	4	OPEN FIELD	1655	1710	15	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	750	820	30	DAILY START, STOP	SETUP	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	820	830	10	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	830	920	50	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	920	935	15	DOWNTIME DUE TO EQUIPMENT FAILURE	AXLE SNAPPED, REPAIRED	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	935	955	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	955	1020	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
6/15/2007	4	OPEN FIELD	1020	1035	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1035	1115	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1115	1135	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1135	1205	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1205	1215	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1215	1310	55	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1310	1355	45	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1355	1410	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1410	1505	55	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1505	1525	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1525	1635	70	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1635	1700	25	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1700	1725	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1725	1735	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1735	1820	45	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	DRY
6/15/2007	4	OPEN FIELD	1820	1835	15	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	CLOUDY	DRY
06/16/07	4	OPEN FIELD	915	945	30	DAILY START, STOP	SETUP	GPS	NA	LINEAR	SUNNY	DRY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
06/16/07	4	OPEN FIELD	945	1000	15	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1000	1030	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1030	1045	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1045	1140	55	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1140	1155	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1155	1235	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1235	1330	55	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1330	1345	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1345	1415	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1415	1425	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1425	1515	50	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1515	1530	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1530	1610	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1610	1625	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1625	1700	35	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1700	1710	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
06/16/07	4	OPEN FIELD	1710	1745	35	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1745	1805	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/16/07	4	OPEN FIELD	1805	1820	15	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	SUNNY	DRY
06/18/07	4	OPEN FIELD	640	710	30	DAILY START, STOP	SETUP	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	710	725	15	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	725	755	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	755	805	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	805	830	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	830	910	40	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	910	930	20	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	930	950	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	950	1020	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1020	1030	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1030	1045	15	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1045	1125	40	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1125	1200	35	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1200	1310	70	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	HOT

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
06/18/07	4	OPEN FIELD	1310	1330	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1330	1410	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1410	1430	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1430	1515	45	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1515	1530	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1530	1550	20	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1550	1700	70	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/18/07	4	OPEN FIELD	1700	1720	20	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	750	815	25	DAILY START, STOP	SETUP	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	815	825	10	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	825	905	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	905	920	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	920	940	20	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	940	950	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	950	1040	50	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1040	1130	50	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1130	1230	60	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
06/19/07	4	OPEN FIELD	1230	1335	65	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1335	1410	35	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1410	1445	35	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1445	1455	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1455	1530	35	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1530	1555	25	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1555	1625	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1625	1645	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1645	1710	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	HOT
06/19/07	4	OPEN FIELD	1710	1730	20	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	CLOUDY	RAIN
06/20/07	4	OPEN FIELD	750	855	65	DAILY START, STOP	SETUP	GPS	NA	LINEAR	CLOUDY	RAIN
06/20/07	4	OPEN FIELD	855	910	15	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	CLOUDY	RAIN
06/20/07	4	OPEN FIELD	910	925	15	DAILY START, STOP	SETUP	GPS	NA	LINEAR	CLOUDY	RAIN
06/20/07	4	OPEN FIELD	925	955	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	RAIN
06/20/07	4	OPEN FIELD	955	1015	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	RAIN
06/20/07	4	OPEN FIELD	1015	1040	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	RAIN
06/20/07	4	OPEN FIELD	1040	1105	25	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	RAIN

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
06/20/07	4	OPEN FIELD	1105	1205	60	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	RAIN
06/20/07	4	OPEN FIELD	1205	1305	60	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	CLOUDY	RAIN
06/20/07	4	OPEN FIELD	1305	1325	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/20/07	4	OPEN FIELD	1325	1400	35	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/20/07	4	OPEN FIELD	1400	1415	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/20/07	4	OPEN FIELD	1415	1455	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/20/07	4	OPEN FIELD	1455	1515	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/20/07	4	OPEN FIELD	1515	1600	45	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/20/07	4	OPEN FIELD	1600	1610	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/20/07	4	OPEN FIELD	1610	1650	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/20/07	4	OPEN FIELD	1650	1705	15	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	SUNNY	DRY
06/25/07	4	OPEN FIELD	750	820	30	DAILY START, STOP	SETUP	GPS	NA	LINEAR	CLOUDY	RAIN
06/25/07	4	OPEN FIELD	820	830	10	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	CLOUDY	RAIN
06/25/07	4	OPEN FIELD	830	920	50	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	RAIN
06/25/07	4	OPEN FIELD	920	945	25	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	RAIN
06/25/07	4	OPEN FIELD	945	1010	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	RAIN

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
06/25/07	4	OPEN FIELD	1010	1020	10	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	CLOUDY	RAIN
06/25/07	4	OPEN FIELD	1020	1115	55	DOWNTIME DUE TO EQUIPMENT FAILURE	BROKEN CABLE CONNECTION, REPAIRED	GPS	NA	LINEAR	CLOUDY	RAIN
06/25/07	4	OPEN FIELD	1115	1205	50	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	CLOUDY	RAIN
06/25/07	4	OPEN FIELD	1205	1225	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/25/07	4	OPEN FIELD	1225	1250	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/25/07	4	OPEN FIELD	1250	1405	75	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	DRY
06/25/07	4	OPEN FIELD	1405	1500	55	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/25/07	4	OPEN FIELD	1500	1525	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/25/07	4	OPEN FIELD	1525	1540	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/25/07	4	OPEN FIELD	1540	1555	15	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/25/07	4	OPEN FIELD	1555	1635	40	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/25/07	4	OPEN FIELD	1635	1700	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/25/07	4	OPEN FIELD	1700	1720	20	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	740	800	20	DAILY START, STOP	SETUP	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	800	815	15	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	815	850	35	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
06/26/07	4	OPEN FIELD	850	910	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	910	935	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	935	950	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	950	1020	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1020	1040	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1040	1115	35	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1115	1135	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1135	1150	15	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1150	1310	80	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1310	1345	35	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1345	1425	40	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1425	1455	30	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1455	1520	25	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1520	1535	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1535	1550	15	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1550	1620	30	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	DRY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

Date	No. of People	Area Tested	Status Start Time	Status Stop Time	Duration, min	Operational Status	Operational Status Comments	Track Method	Track Method=Other Explain	Pattern	Field Conditions	
06/26/07	4	OPEN FIELD	1620	1655	35	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1655	1725	30	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/26/07	4	OPEN FIELD	1725	1740	15	DAILY START, STOP	BREAKDOWN	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	CALIBRATION LANES	845	925	40	DAILY START, STOP	SETUP	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	CALIBRATION LANES	925	935	10	CALIBRATION	CALIBRATION	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	CALIBRATION LANES	935	1030	55	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	CALIBRATION LANES	1030	1100	30	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	CALIBRATION LANES	1100	1110	10	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	BLIND TEST GRID	1110	1130	20	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	BLIND TEST GRID	1130	1225	55	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	BLIND TEST GRID	1225	1335	70	BREAK/LUNCH	LUNCH/BREAK	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	BLIND TEST GRID	1335	1350	15	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	BLIND TEST GRID	1350	1530	100	COLLECTING DATA	COLLECTING DATA	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	BLIND TEST GRID	1530	1730	120	WEATHER ISSUE	LIGHTNING WARNING	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	CALIBRATION LANES	1730	1755	25	DAILY START, STOP	SETUP, MOVING WIRE TO NEXT GRID	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	CALIBRATION LANES	1755	1850	55	COLLECTING DATA	COLLECTING DATA IN TEST PIT	GPS	NA	LINEAR	SUNNY	DRY
06/27/07	4	CALIBRATION LANES	1850	2030	100	DEMOBILIZE	DEMOBILIZATION	GPS	NA	LINEAR	SUNNY	DRY

Note: Activities pertinent to this specific demonstration are indicated in highlighted text.

APPENDIX E. REFERENCES

1. Standardized UXO Technology Demonstration Site Handbook, DTC Project No. 8-CO-160-000-473, Report No. ATC-8349, March 2002.

2. Aberdeen Proving Ground Soil Survey Report, October 1998.

3. Data Summary, UXO Standardized Test Site: APG Soils Description, May 2002.

4. Yuma Proving Ground Soil Survey Report, May 2003.

APPENDIX F. ABBREVIATIONS

APG	=	U.S. Aberdeen Proving Ground
ATC	=	U.S. Army Aberdeen Test Center
DMM	=	discarded military munitions
EM	=	electromagnetic
EMI	=	electromagnetic interference
ERDC	=	U.S. Army Corps of Engineers Engineer Research and Development Center
EST	=	Eastern Standard Time
ESTCP	=	Environmental Security Technology Certification Program
EQT	=	Army Environmental Quality Technology Program
GPS	=	Global Positioning System
HEAT	=	high-explosive antitank
JPG	=	Jefferson Proving Ground
MAG	=	Magnetomter
MEC	=	munitions and explosives of concern
NS	=	nonstandard
POC	=	point of contact
QA	=	quality assurance
QC	=	quality control
ROC	=	receiver-operating characteristic
RTK	=	real-time kinematic
RTS	=	robotic total station
SAM	=	Sub Audio Magnetics
SERDP	=	Strategic Environmental Research and Development Program
TFEMI	=	Total Field Electromagnetic Induction
TMI	=	Total Magnetic Intensity
TNT	=	trinotrotulene
USAEC	=	U.S. Army Environmental Command
UXO	=	unexploded ordnance
YPG	=	U.S. Army Yuma Proving Ground

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